Suomen Ääniergonomiaseuran viides symposium
Finlands Röstergonomisällskaps femte symposium
5th symposium of the Finnish Society of Voice Ergonomics

Occupational voice and working environment

What is happening in the field of voice ergonomics?

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http://www.aaniergonomiaseura.com/symposium-2016.html

Welcome words **Eeva Sala**, MD, PhD, Docent in phoniatrics | Turku University, Turku, Finland	
Active learning in modern schools **Markku Lang**, KM, TaM, Future Classroom Lead Ambassador at European Schoolnet | European Schoolnet, Oulu University Teacher Training School, Oulu, Finland	
Open plan schools: challenges of their acoustics **Bridget Shield**, Professor Emerita of Acoustics | The School of the Built Environment and Architecture, London South Bank University, UK	
Presentation on Finnish voice ergonomic studies **Leena M. Rantala**, PhD, senior lecturer | School of Social Sciences and Humanities, University of Tampere, Tampere, Finland	
Development of the voice ergonomics field in Sweden **Maria Södersten**, associate professor | Karolinska institutet, Stockholm, Sweden	
Pedagogy affects activity noise **Valdis Jónsdóttir**, PhD, speech therapist | Thad er malid, Akureyri, Iceland	
Indoor climate – what are the health risk factors **Tuula Putus**, professor of environmental medicine | Turku University, Turku, Finland	
Monitoring voice over a long period **Arianna Astolfi**, associate professor | Department of Energy, Politecnico di Torino, Torino, Italy	
Voice ergonomic risk factors in classrooms of some European countries - comparison **Baiba Trinite**, PhD, assistant professor, speech therapist | Liepaja University, Latvia	
Work-related voice disorders – results from multiple studies using the same questionnaire **Susanna Simberg,** professor, emerita | Åbo Akademi, Turku, Finland	
Stress is a risk factor for voice disorders - Why and for whom? **Sofia Holmqvist,** doctorand student | Åbo Akademi, Turku, Finland	
How does a hoarse teacher voice affect students' performance and attitudes **Viveca Lyberg Åhlander**, associate professor, speech therapist | Lund University	
Voice ergonomics and children – future occupational voice users **Anita McAllister,** professor, speech therapist | Karolinska institutet, Stockholm, Sweden	
Voice Parameters and Acoustics in Schools **Nicholas Durup**, PhD Researcher | Department of Urban Engineering, Faculty of Engineering, Science and Built Environment London South Bank University, UK.	
Examples of acoustic treatments in school classrooms **Pauli Pallaskorpi**, Concept Developer Education | Ecophon, Helsinki, Finland	
Discussions - What we can do in practice? **Elina Kankare**, PhD, speech therapist | Department of Phoniatrics, Tampere University Hospital, Tampere, Finland	

Active learning in modern schools

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We know that world is changing and in near future workforce is going to be more independent, contingent and temporary. Therefore future learning environments and learning activities are essential to prepare all students for the challenges of work and life. Finland is starting this school year with a new core curriculum for basic education, which is focusing on developing future skills (developing the key competences as it is described in curriculum). To train and to develop future skills in schools new methods and activities are needed. But how do these future learning activities look and sound like? What are teachers and students doing? Can school design support it?

Open plan schools: Their acoustics challenges

Bridget Shield Professor Emerita of Acoustics | The School of the Built Environment and Architecture, London South Bank University, London, UK | shieldbm@lsbu.ac.uk

This presentation will trace the history of the development of open plan classrooms in the UK, from their introduction in the 1960s to present day open plan designs. The requirements for good acoustic conditions for teaching and learning will be discussed and the difficulties of achieving such conditions in open plan spaces explored. The results of some acoustic and noise surveys of open plan and other primary and secondary school classrooms will be presented, together with results of questionnaire surveys of pupils and teachers in open plan schools. The presentation will also illustrate some remedial treatments that have been applied in schools with acoustic problems due to their open plan design, and will conclude with some recommendations for minimising problems at the design stage.

The effects of noise on pupils and teachers: a review of 15 years research

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Since 1999 the Acoustics group at London South Bank University has been involved in research in the area of classroom acoustics, in particular investigating the effects of noise and poor acoustic design on pupils and teachers. The majority of the research has been carried out in collaboration with Professor Julie Dockrell of the Institute of Education and has been funded by government research grants. Work has been undertaken in primary schools in central London and south east England, and in secondary schools around the country. In all the schools questionnaire surveys have been carried out to gauge the attitudes of pupils and teachers towards noise in terms of annoyance and the impact of noise upon speaking and listening in the classroom. The effects of noise on pupils' academic performance has been investigated by comparing noise levels with primary school scores in standardised tests, and by experimental testing of both primary and secondary school pupils in quiet and noisy conditions. Results of the research have been used to inform the introduction in 2003 and revision in

2014 of national building regulations on the acoustic design of schools. The presentation will show some results from the research in primary and secondary schools concerning attitudes to noise, effects of noise on pupil performance and the impact of noise on teachers' health.

Book chapters

J Dockrell, B Shield B and K Rigby. Acoustic guidelines and teacher strategies for optimising learning conditions in classrooms for children with hearing problems. Chapter 23 in 'Access: Achieving Clear Communication Employing Sound Solutions 2003', Phonak, 2004.

B M Shield and J E Dockrell. The effects of noise on children at school: a review. In 'Collected papers in Building Acoustics: Room Acoustics and Environmental Noise (ed B Gibbs, J Goodchild, C Hopkins and D Oldham), 159-182, 2010, ISBN 978-1-907132-14-8

Journal papers

B M Shield and J E Dockrell. The effects of noise on children at school: a review. J. Building Acoustics 10(2), 97-106, 2003

B M Shield and J E Dockrell. External and internal noise surveys of London primary schools. J. Acoustical Society of America 115 (2), 730-738, 2004

J E Dockrell and B Shield. Children's perceptions of their acoustic environment at school and at home. J. Acoustical Society of America 115(6), 2964-2973, 2004

J Dockrell and B Shield. Acoustical barriers in classrooms: the impact of noise on performance in the classroom. British J Educational Research 32(3), 509-525, 2006.

B M Shield and J E Dockrell The effects of environmental and classroom noise on the academic attainments of primary school children. J. Acoustical Society of America, 123(1), 133-144, 2008

Bridget Shield, Emma Greenland and Julie Dockrell. Noise in open plan classrooms: a review. Noise and Health 12:49, 225-34, October-December 2010

E Greenland and B Shield. A survey of acoustic conditions in semi-open plan classrooms in the United Kingdom. J. Acoustical Society of America 130(3), 1399-1410, 2011

P Kendrick, N Shiers, R Conetta, T Cox, B Shield and C Mydlarz. Blind estimation of reverberation time in classrooms and hospital wards. Applied Acoustics 73(8), 770-780, 2012

J Dockrell and B Shield. The Impact of Sound-Field Systems on Learning and Attention in Elementary School Classrooms. J Speech Lang Hear Res 55, 1163 – 1176, 2012

D Connolly, J Dockrell, B Shield, R Conetta and T Cox. Adolescents' perceptions of their school's acoustic environment. Noise and Health 15: 65, 269-280, July-August 2013

C Mydlarz, R Conetta, D Connolly, T Cox, J Dockrell and B Shield. Comparison of environmental and acoustic factors in occupied school classrooms for 11 – 16 year old students. Building and Environment 60, 265-271, 2013

Bridget Shield, Robert Conetta, Julie Dockrell, Daniel Connolly, Trevor Cox and Charles Mydlarz A survey of acoustic conditions and noise levels in secondary school classrooms in England. J. Acoustical Society of America 131(3), 177-188, 2015

Presentation on Finnish voice ergonomic studies

Suomalainen ääniergonomiatutkimus

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Ääniergonomia – Toimiva ääni työvälineenä kirjan määritelmä mitä ääniergonomia on

Ääniergonomialla tarkoitetaan kaikkia niitä toimenpiteitä, jotka parantavat edellytyksiä hyvään äänen tuottoon ja puhumiseen, puheen kuulemiseen ja erottamiseen eli puheviestintään. Laajasti ymmärrettynä ääniergonomialla tarkoitetaan myös melun kaikkien haittavaikutusten vähentämistä. Ääniergonomiatoimenpiteiden tavoitteena on ehkäistä äänihäiriöiden syntyä, parantaa toipumismahdollisuuksia ja pienentää äänihäiriön aiheuttamaa haittaa. Tämä sisältää toimenpiteitä sekä yksilötasolla että puheviestintäolosuhteissa.

Yksilötasolla toimenpiteet ovat omasta terveydestä, erityisesti äänielimistön terveydestä sekä äänielimistön hyvästä toimintakunnosta huolehtimista. Terveydestä huolehtiminen sisältää sairauksien ennaltaehkäisyä ja sairauksien tehokkaan hoidon. Äänielimistön toimintavalmiudesta voi huolehtia tekemällä äänenavaus- ja rentoutusharjoituksia.

Ympäristöön kohdistuvilla ääniergonomiatoimenpiteillä tarkoitetaan ympäristön ääniolosuhteiden, työskentelyasentojen ja ilmanlaadun muokkaamista puheviestintään sopiviksi.

Suomalainen ääniergonominen tutkimus on saapumassa aikuisikään: tutkimusta on takana jo 30 vuotta. Vaikka varhaisissa tutkimusartikkeleissa ei vielä käytettykään termiä *ääniergonomia*, niin äänielimistön terveydestä sekä äänen ja viestinnän toimivuudesta huolta kantavan alan juuret olivat jo näkyvissä: ensimmäisissä tutkimuksissa selvitettiin lämpötilan, melun ja kehon tärinän eli ympäristötekijöiden vaikutusta puheeseen ja ääneen sekä luokkahuoneiden akustiikan vaikutusta opetusviestintään.

Tieteenalat, joita ääniergonomia on kiinnostanut, ovat olleet lääketieteen alueelta foniatria ja humanistisista tieteistä logopedia sekä varsin uusi, fonetiikasta eriytynyt ihmisääntä tutkiva ala, vokologia. Suomalaisia julkaisuja ääniergonomian alalta on maamme pieneen asukasmäärään nähden paljon: ääniergonomiaa käsitteleviä väitöskirjoja on valmistunut 7 ja artikkeleita kansainvälisissä julkaisuissa on vähintään 70, todennäköisesti enemmänkin. Lisäksi ääniergonomiasta on julkaistu kaksi käytännönläheistä kirjaa: *Ääniergonomia – toimiva ääni työvälineenä* ja *Ääniergonomian kartoitusopas.*

Tässä katsauksessa emme kerro maamme ääniergonomisen tutkimuksen kehityksestä kronologisesti vaan käsittelemme saatuja tuloksia teemoittain. Tutkimusten tavoitteet tiivistyvät seuraaviksi tutkimuskysymyksiksi: (1) Vaikuttavatko ääniergonomiset riskitekijät puheäänen? (2) Minkälainen on ääniergonominen tilanne suomalaisella työpaikalla? ja (3) Vaikuttaako ääniergonominen interventio? Koska jo aiemmista tutkimuksista ja kliinisestä kokemuksesta tiedetään, että opettaja käyttää ääntään työpäivän aikana runsaasti ja myös oireilee paljon, suurin osa tutkimuksista on kerännyt aineistonsa opettajilta ja opettajien työympäristöstä eli luokkahuoneista.

Kaikki ääniergonomiset tutkimukset ovat olleet luonteeltaan kvantitatiivisia. Aineistoa on kerätty kyselyillä, haastattelemalla ja tekemällä havaintoja äänestä laboratoriossa tai aidoissa työympäristöissä. Kyselytutkimuksissa on yleisimmin kartoitettu äänioireiden esiintyvyyttä. Suurimmassa kyselytutkimuksessa tutkittavien määrä oli 1728 (identtisiä ja epäidenttisiä kaksosia). Ääniergonomisten riskitekijöiden kartoitus tehtiin sen sijaan haastatteluna (N=40). Äänen käyttäytymistä kuormituksen aikana on tutkittu yhdessä laboratoriotutkimuksessa (N=80) ja neljässä, luonnollisessa työympäristössä tehdyssä (koulu, puhelimitse tapahtuva asiakaspalvelu) tutkimuksessa (N=32–79). Tutkimushenkilöinä on ollut terveäänisiä puhujia ja työntekijöitä, joiden tiedetään työskentelevän ääntä kuormittavassa ympäristössä (opettajat, lastentarhanopettajat ja asiakaspalvelu). Vaikka suurin osa tutkimushenkilöistä on ollut naisia, myös miesten äänenkäyttöä on tutkittu.

Vaikuttavatko ääniergonomiset riskitekijät puheäänen?

Tutkimustulosten mukaan ympäristö ja äänenkäyttö vaikuttavat äänioireiden määrään ja siihen, miten ääni muuttuu kuormittavissa tilanteissa. Kaksostutkimus osoittaa, että ympäristötekijät selittävät 65 % äänihäiriöiden ilmaantuvuudesta ja täysin oireen *ääni rasittuu ja väsyy*. Myös äänioirekartoitukset vahvistavat käsitystä, että työ ja työympäristö vaikuttavat ääneen: opettajista ja lastentarhanopettajista 50–70 % kokee vähintäänkin kuukausittain mutta osa jopa päivittäin äänioireita, ja 11–29 %:lla on havaittavissa äänihuulissa näkyviä orgaanisia muutoksia.

Eri ammattiryhmien vertailu - opettajat versus sairaanhoitajat - tukee niin ikään päätelmää, että eri työympäristöissä on eri määrä äänihäiriön riskitekijöitä. Opettajat nimittäin kärsivät äänioireista selvästi useammin ja oireet kestävät pitempään kuin sairaanhoitajilla, jotka puhuvat suurin piirtein saman verran työpäivänsä aikana kuin opettajat mutta eivät joudu voimistaa ääntään puhe-etäisyyden tai taustamelun vuoksi. Lisäksi äänioirekartoitukset osoittavat huolestuttavan suuntauksen: äänioireista kärsivien opettajien määrä on kasvanut. Työkulttuurin ja ehkä jopa laajemmin yhteiskuntamme toimintakulttuurin muutoksesta kertonee se, että myös entistä useampi sairaanhoitaja kärsii äänioireista. Äänioireisten opettajien määrä on kasvanut kuitenkin nopeammin kuin oireilevien sairaanhoitajien määrä.

Äänenkuormittaminen - pitkä puheaika, voimistettu ääni - lisää väsymyksen tunnetta kurkussa ja muuttaa äänen akustisia piirteistä. Tyypillisin muutos puheäänessä on äänenkorkeuden nousu. Korkeuden nousua ei sinänsä voi pitää häiriöön viittaavana piirteenä, vaan se kuvannee varsinkin äänenkäytön alkuvaiheessa äänielimistön lämpiämistä. Puhekorkeuden nousu työpäivän aikana onkin systemaattisempaa terveäänisillä puhujilla kuin äänioireita kokevilla. Joissakin tutkimuksissa – ei kuitenkaan kaikissa - on havaittu myös äänenvoimakkuuden nousevan äänenkäytön aikana.

Äänen kuormittaminen muuttaa myös puhujan äänenspektriä. Spektrimuutos viittaa puhujan äänentuottotavan muuttuvan hyperfunktionaalisempaan (puristeisempaan) suuntaan kuormituksen edetessä. Äänen kuormittaminen nostaa myös äänihuulten alaista ilmanpainetta ja äänihuulivärähtelyn aikaan saamiseksi tarvittavaa kynnyspainetta. Myös nämä muutokset viittaavat äänenkäytön muuttuvan puristeisemmaksi.

Suurin osa tutkimuksissa tehdyistä havainnoista koskee naisten ääntä, mutta äänenkäyttö kuormittaa myös miesten äänielimistöä. Lisäksi tutkimustulokset osoittavat, että äänioireet, äänen akustiset piirteet ja visuaalisesti havaittavat orgaaniset muutokset äänihuulissa eivät korreloi keskenään, mikä viitannee siihen, että tutkimuksissa käytetyt muuttujat mittaavat ja arvioivat eri puolia äänestä ja äänenkäytöstä.

Minkälainen on ääniergonominen tilanne suomalaisella työpaikalla (koululuokissa)?

Suomaisen työpaikan ääniergonomista tilannetta on kartoitettu systemaattisimmin kouluissa (14 koulua, 40 luokkahuonetta). Tulokset osoittavat, että luokissa on paljon äänenkäyttöön liittyviä riskitekijöitä, eivätkä opetustilojen akustiikalle asetetut, suomalaisen Standardin (SFS 5907) mukaiset kriteerit useinkaan täyty. Eniten erilaisia riskitekijöitä löytyy opettajan työskentelytapaan liittyvästä äänenkäytöstä (tutkittiin yhteensä 9 riskitekijää). Lähes kaikki tutkitut opettajat (98 %) kokivat käyttävänsä voimakasta ääntä pitkiä aikoja. Kysytyistä 16 sisäilman laatuun liittyvistä riskitekijöistä löytyi luokista lähes puolet (44 %). Näistä tyypillisimpiä olivat pölyä keräävät materiaalit (90 % luokissa) ja pinnoilla havaittava pöly (85 %). Työskentelyasentoihin (11 riskitekijää), meluun ja kaiuntaan (18 riskitekijää) liittyvistä tekijöistä löytyi luokista reilu kolmasosa.

Taustamelu (mittaus tyhjässä luokassa) on suurimmassa osassa luokista (88 %:ssa) liian korkea. Tilanne ei ole muuttunut ensimmäisistä 1990-luvun alussa tehdyistä mittauksista. Myös oppilaiden ja opettajan työskentelystä aiheutuva oppituntien aikainen aktiivimelu (L_{Aeq} 69 dB) on yleensä liian korkea sekä puheen kuulemiselle ja äänenkäytölle. Jälkikaiunta-aika ei niin ikään ole useinkaan suosituksen mukainen: 22 %:ssa luokista se oli liian pitkä ja 43 %:ssa liian lyhyt. Puheen ymmärrettävyyttä (speech intelligibility) mittaava puheen siirtoindeksi

(speech transmission index, STI) ei myöskään ole riittävä opetuksessa: vain yhdessä luokassa 40:stä indeksin arvo oli riittävän korkea.

Miten riskitekijät vaikuttavat ääneen?

Koululuokissa tehty äänen riskitekijöiden (melu ja akustiikka, sisäilma, työskentelyasennot, toimintakäytännöt ja stressi) kartoitus osoitti, että mitä enemmän luokasta löytyy riskitekijöitä, sitä vakavampia (vaikea-asteisempia, runsaampia ja pitkäkestoisempia) ovat opettajan äänioireet. Lisäksi riskitekijöiden määrä vaikuttaa tapaan käyttää ääntä: jos riskitekijöitä on paljon, opettajalla on taipumus puhua voimakkaammalla äänellä, mikä tulee esille jo ennen työpäivän alkua (pitkäaikaisvaikutus). Voimakas ääni voi ilmentää kroonista kuormitusvaikutusta, mikä ei sinänsä tarkoita vielä äänen rasittumista, vaan opettaja ehkä joko kompensoi äänen laadun heikkenemistä tai sitten hän on adaptoitunut voimistettuun äänentuottotapaan.

Riskitekijöistä stressi on voimakkaimmin yhteydessä äänioireisiin. Työskentelytapaan liittyvä äänenkäyttö (etäältä puhuminen, pitkään puhuminen, äänen voimistaminen jne.) vaikuttaa useampaan äänen akustiseen piirteeseen (äänenperustaajuus, puheäänentaso, äänentuottotapaa ilmaiseva pitkäaikaisspektri) kuin muut riskitekijät. Huono sisäilman laatu puolestaan lisää riskiä sairastua kurkunpään tulehdukseen.

Melun laatu – rakennukseen liittyvistä laitteista aiheutuva taustamelu tai ihmisten toiminnasta johtuva aktiivimelu - vaikuttaa eri tavoin äänen. Kun ympäristön melu on suurempi, opettaja käyttää voimakkaampaa ääntä, mikä tuli esille erityisesti ennen opetuksen alkua mitatuissa ääninäytteissä. Jos taas opetuksen aikainen aktiivimelutaso on korkeampi, opettajan äänen akustiset piirteet muuttuvat vähemmän työpäivän aikana kuin hiljaisemman luokan opettajalla. Tämä tulos viittaa siihen, että korkea aktiivimelutaso heikentää elimistön kykyä reagoida luonnollisella tavalla kuormitukseen ja väsymiseen (ceiling effect). Muuttumattomuus tai pienempi muutos onkin siis patologinen merkki ja ilmentänee äänielimistön ylikuormittumista.

Luokkahuoneen melutaso vaikuttaa siihen, miten huoneen akustiset ominaisuudet (parametrit, jotka mittaavat jälkikaiunta-aikaaT_{60} ja EDT; puheen selkeyttä kuulijalle $C_{50,}$ $D_{50,}$ STI; ja äänen vaimentumista DL_2) vaikuttavat puheääneen. Jos luokan akustiset ominaisuudet ilmaisevat parempaa ympäristöä kuuntelulle, niin äänen akustiset piirteet viittaavat kuormittuneempaan tai oireilevampaan ääneen.

Lisäksi opettajat ovat kyselytutkimuksessa tuoneet esille, että äänihäiriön riski on kasvanut luokassa. Esimerkiksi oppilaiden häiriökäyttäytyminen ja meluisuus ovat lisääntyneet. Yhtenä syynä tähän on opettajien mukaan ryhmäkokojen kasvu.

Interventioiden vaikutus ääneen

Interventiotutkimuksia on tehty vain muutamia. Opettajat, opettajaksi opiskelevat ja puhelinpalvelutyötä tekevät ovat saaneet ohjausta taloudelliseen äänenkäyttöön (lyhyitä kursseja). Yhdessä tutkimuksessa verrattiin äänenharjoituskurssin ja ääniluennon vaikutuksia toisiinsa. Kurssilla olleiden äänioireet vähenivät ja äänentuottotekniikka parani enemmän kuin pelkästään luentoa kuunnelleilla. Vuoden seurannan jälkeen tehty

kyselytutkimus osoitti, että molemmilla ryhmillä oli äänioireita vähemmän kuin ennen interventioita. Sen sijaan ryhmät eivät eronneet oireiden suhteen toisistaan.

Oulussa on tehty pienimuotoinen tutkimus kahdessa luokassa siitä, voidaanko luokan ääniergonomiaa parantaa tiedottamalla oppilaille ja opettajille meluhaitoista ja ohjaamalla heitä pohtimaan ja etsimään meluttomia toimintatapoja. Tulokset ovat rohkaisevia: oppilaat ideoivat monipuolisesti keinoja vähentää melua. Lisäksi opettajat arvioivat, että oppilaat tiedostivat aiempaa paremmin melua ja sen haittoja sekä pyrkivät vähentämään sitä.

Tutkimustulosten viesti niille, jotka vaikuttavat ääniergonomisiin ratkaisuihin

Suomalaiset tutkimukset osoittavat varsin yksiselitteisesti, että niiden, jotka ovat vastuussa opetustilojen suunnittelusta ja rakentamisesta, pitäisi ottaa vakavasti huomioon ääniergonomiaan vaikuttavat tekijät, koska

- ympäristötekijät selittävät äänihäiriöön sairastumista enemmän kuin geneettiset tekijät.
- äänihäiriöt, kuten esimerkiksi äänihuulikyhmyt, täyttävät ammattitaudille asetetut kriteerit.
- opettajien äänihäiriöt lisääntyvät.
- luokkahuoneissa on paljon äänihäiriötä aiheuttavia tekijöitä. Myös luokan akustiset olosuhteet ovat äänenkäytölle huonot.
- hyvä luokkahuoneakustiikka on kompromissi olosuhteista, jotka takaavat hyvän puheen kuulemisen ja tuoton.

SANOJEN MÄÄRITTELYÄ

Äänielimistö kuormittuminen puhuessa on normaalia tiettyyn rajaan asti.

Kun **äänielimistö ylikuormittuu**, äänielimistöstä tulee oireita ja kuormittuminen vaikuttaa suoriutumiseen. Tällaista tilannetta kutsutaan ”äänen rasittumiseksi”.

Kun **ääni rasittuu**, sillä tarkoitetaan, että äänielimistö ylikuormittuu ja äänen käyttöön liittyy oireita.

Ääniergonomialla tarkoitetaan havainnointia ja toimenpiteitä, jotka vähentävät äänihäiriön riskiä. Näitä tekijöitä voi olla yksilötasolla ja ympäristössä.

Ääniergonomisia riskitekijöitä ovat melu ja akustiikka, sisäilman laatu, työskentely-asennot, toimintakäytännöt ja stressi sekä äänielimistön terveyteen liittyvien tekijöiden laiminlyönti.

Äänen hyvinvoinnilla tarkoitetaan, että äänielimistö on terve ja ääni on toimiva.

Äänihygienialla tarkoitetaan yksilön käyttäytymiseen liittyviä tapoja ja käytäntöjä, jotka lisäävät äänihäiriön riskiä. Sen tilalla nykyään käytämme ilmaisua **yksilökohtainen ääniergonomia**.

Aktiivimelulla tarkoitetaan ihmisten toiminnasta aiheutuvaa melua, joka sisältää mm. luokassa käytetyistä laitteista, liikkumisesta, puhumisesta ja kalusteiden siirtelystä aiheutuvan melun.

Taustamelulla (ambient noise, background noise) tarkoitetaan tässä rakennukseen liittyvien laitteiden ja ulkoa kantautuvien äänten (liikenne ym.) aiheuttamaa melua rakennuksen sisällä.

Puheen havaitsemisella tarkoitetaan sitä, että kuulee puheen eli havaitsee, että puhutaan, mutta ei erota äänteitä eikä siten saa selvää mitä puhutaan.

Levels of auditory skill development

Detection: presence or absence of sound.

Discrimination: Distinguishing between two speech sounds: Are “da” and “tha” same or different?

Recognition: This is a closed set task that involves selecting a target from a known list of alternatives.

Identification: This is an open-set task that involves noting target from an infinite set of alternatives.

Comprehension: This is the highest level of auditory skill development. Comprehension is achieved when one can answer questions, follow directions and hold a conversation.

Katsaukseen liittyvät artikkelit

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Development of the voice ergonomics field in Sweden

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This presentation will give an overview of research projects within the area of voice ergonomics in Sweden. Furthermore information will be given about contacts with the Swedish Work Environment Authority (SWEA) with the aim to spread knowledge about the area. Research has focused on development of equipment to measure voice use and environmental noise levels during long-term recordings at work and leisure time, such as a voice accumulator, binaural DAT-recorder, and the Voxlog system. In several studies it has been found that speaking pitch and voice level area significantly higher during work as compared to conversational speech, and that the level of environmental noise is high in pre-school settings, in average 76 dBA. In an ongoing project of female patients with voice disorders and vocally-demanding work and age- and workplace matched controls also subjective ratings of vocal fatigue and hoarseness are measured four times a day. Preliminary findings show that there were statistically significant differences between work and leisure regarding phonation time ratio, the time the vocal fold vibrate. The patients rated significantly higher ratings of voice symptoms than the controls. The Swedish Work Environment Authority (SWEA) requested a knowledge compilation of occupational voice disorders and voice ergonomics in 2010, which was published 2011. SWEA took the initiative for a checklist for assessment of voice ergonomics factors and also included information about risk for voice problems when the AFS (Acts and regulations) “Ergonomics” from 1998 was revised 2012. SWEA has new information about voice ergonomics and vocal loading on the web-site. Our division at Karolinska Institutet has arranged two free-standing courses about Occupational voice disorders, one in 2007 and one 2010. The next course ”Work-related voice disorders and voice ergonomics” is planned to the spring 2017 and aim to educate participants with different professional background within the field, e g., physicians, ergonomists, acousticians, engineers and speech language pathologists. The Swedish national voice ergonomics network did recently become part of the Ergonomics Human Factors Society Sweden, a larger organization for ergonomics. This may be an important step to develop the field of voice ergonomics further.

Pedagogy affects activity noise

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According to Icelandic Occupation Health and Safety legislation, in places such as offices where important discussions are conducted or a high degree of concentration is required, the noise level (undefined) should be no more than 50 L_{Aeq8h}. Activity noise levels measured in Icelandic preschools exceed those recommended noise levels by 20-25 dB which is too high for oral education especially as children are developing language at that age. 90% of children at the age of 1 - 5 years are attending Icelandic preschools, almost all of them for 8 hours a day and 5 days a week.

The aim of this study was to survey teachers´ experience of noise in Icelandic preschools and find out if/how different school policies might affect noise levels in preschools. A questionnaire study was carried out in 8 Icelandic private preschools with their own school policy or pedagogical ideology ("Hjalli-model") and in 6 public preschools. The “Hjalli-model” preschools follow their own ideology with specific policies for instance, regarding toys, guidance on behavior and gender separation. There were no significant differences in working ages nor living ages. Salaries were the same. Noise measurements were carried out in one of the private schools and in one of the public ones.

According to the results in general teachers experienced the greatest noise from the children themselves; from building blocks and from school routines in general. Significantly fewer "Hjalli-model" teachers reported vocal symptoms, fewer experienced vocal symptoms during wintertime and in the evenings and statistically less noise was measured in the “Hjalli-model” preschools. School policies, with tighter control of discipline, may lower the noise in preschools. Choosing less noisy toys and having groups with fewer children can lead to more positive and quieter learning environments by decreasing noise levels.

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Indoor climate – what are the health risk factors

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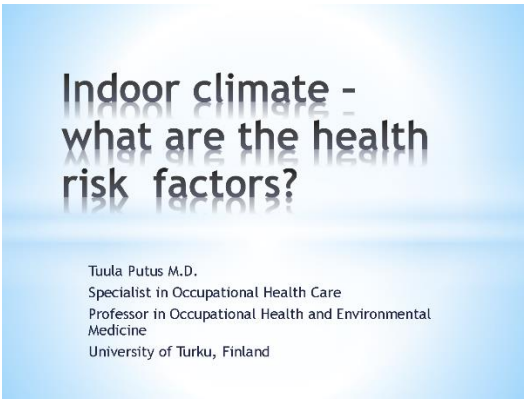

Monitoring voice over a long period

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The growing interest in the protection of voice and new rules on the recognition of voice disorders as occupational diseases require screening methods capable of identifying voice professionals at risk of dysphonia and tools to carry out non-invasively monitoring of the quality of voice over time.

Politecnico di Torino, in collaboration with S.C. ENT 2 U. of the University of Turin and the PR.O.VOICE srl, start-up incubated in I3P of the Politecnico di Torino, has designed two wearable devices, based on the Voice Care® technology, which allow monitoring of voice activity for voice professionals. It consists of a light version, the "Vocal Holter app", low cost, to be installed on a common smartphone, and a pro version, the "Vocal Holter med", made up of a dedicated device, aimed at physicians and speech pathologists, and able to perform more extensive and personalised analysis. The devices monitor voice parameters related to intensity, intonation and vocal load and, in addition to the traditional ones, they monitor the Smoothed Cepstral Peak Prominence (CPPS), a new parameter considered the most promising predictor of dysphonia and its severity. The analysis and results are based on the distributions of occurrences of these parameters, in order to obtain more and more reliable information on the vocal characteristics of the person under test. The equipment allows downloading and saving data on a dedicated web site for further processing, comparisons over time or sharing with physicians or rehabilitators. According to the voice monitoring results protocols for voice care are also provided.

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A Longitudinal Study on Vocal Behaviour of Teachers in Classrooms and Relationships with Classroom Acoustics

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The objective of the longitudinal study presented in this work is twofold: to determine changes in the voice use of teachers along a school year and to study the relationships between voice and classroom acoustics parameters, which account for the background noise level during the teaching hours too. Thirty-one teachers from two secondary schools in Torino (Italy) were involved at the beginning of a school year and twenty-two of them participated in the monitoring campaign also at the end of the same school year too. Teachers adjust their voice significantly with noise and reverberation, both at the beginning and at the end of a school year. Moreover, teachers who worked in worst classroom acoustic conditions showed higher voice sound pressure levels at the

end of the school year. Finally, a good predictive model to estimate the sound pressure level in front of the speaker's mouth from the background noise level and the reverberation time was found.

Voice ergonomics risk factors in classrooms of Latvia

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Voice disorders are a common problem in the teacher's profession. Voice overloading, neglect of vocal hygiene, inappropriate room acoustics and air quality, stress and health problems are the main groups of risk factors promoting occupational voice disorders in the teachers' population.

The prevalence of voice problems in the population of teachers of Latvia is high – 66.7% of teachers had had problems with the voice during their working career (Trinite, 2013). The aim of the study was to investigate teachers' voice ergonomic factors[1] and determine the acoustic changes of teachers' voices during the workday.

Material and methods

Twenty-three classrooms of one school were observed during the study. Twenty-one teachers (19 females, 2 males) were included in the study. The following survey methods were used in the study: The Voice Ergonomics Assessment in Work Environment checklist, the modified Voice Risk Factors questionnaire, Voice Handicap Index. The voice acoustic assessment in teachers was carried out twice – in the morning before the lessons and in the afternoon after the last lesson. $F0_{sv}$, $F0_{cs}$, SPL, Jitt, Shim parameters were extracted from the voice samples. The voice sample consists from the 3 sec sustained vowel production and reading of two sentences of phonetically balanced text in Latvian. The AVQI before and after the workday was calculated based on the recorded voice samples. The MDVP software (CSL, KayPentax) and programme PRAAT were used for the acoustic analysis.

Results

The mean value of simultaneous noise caused by noise sources in the empty classroom was LA_{eq1min} 47 dB (A). The main sources of the noise were computer, data projector, and lamps. The mean value of the noise from outdoors was LA_{eq1min} 52 dB (A). The doors of the classrooms did not provide sound isolation from the corridor. During the routine working period the average level of activity noise in the classrooms varied from 54 to 85 dB (A), mean LA_{eq1min} 73 dB (A). The high level of reverberation was observed in 90% of classrooms.

Indoor air quality. The room temperature and relative humidity were measured by calibrated device. The mean temperature in the classrooms was 21^0C, relative humidity of the air 32%. We observed the presence of dust in 96% of classrooms. Most of the classrooms had chalk blackboards that increased the air dustiness.

Working postures and working practice. 44% of the teachers kept the head in turn posture, 26% turned the body on side, and 26% tensed and rose up shoulders while speaking. 78% of teachers spoke in a loud voice during the lessons and 74% of them considered that voice use is excessive. At the same time more than 90% of teachers thought that they have possibility to decrease voice use, rest voice during the breaks, and use more audio-visual equipment (78%).

Teacher centred approach dominated in schools of Latvia. Lectures, discussions, and questions and answers were the main teaching methods. Teachers preferred to use frontal instructions in their daily work.

Health factors. Three teachers had 2 voice symptoms every day and/or weekly, seven teachers had 1 voice symptom. 86% of teachers have never attended ENT for laryngeal examination. The mean VHI was 13.11 (8.01).

Voice acoustic changes. Although all acoustic parameters changed from the first to the second voice assessment, statistically significant differences were found only for the parameter of fundamental frequency in continuous speech, $p<0.001$. A statistically significant differences between two measurements of AVQI were not found. A statistically significant correlation between afternoon AVQI and number of teaching hours was found $r= 0.575$, $p<0.01$.

Conclusions

The assessment of voice ergonomics in the working environment identifies problems in classroom acoustics, noise conditions, and indoor air quality. The results of the acoustic voice assessment should be interpreted cautiously due to the small study sample. There is a tendency that F0, SPL, and AVQI change during the workday. Environmental and health factors have impact on voice. Motivation – the psychological force that enables action. The focus on action has to be improved in the discussion about teachers' voice health. Action to change the environment, the attitude to voice hygiene, to working practice. The psychological instruments investigating motivation should be included in the teachers' voice ergonomics studies.

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Work-related voice disorders – results from multiple studies using the same questionnaire

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The importance of the voice as an occupational tool in a number of professions today is unambiguous. The results of studies concerning voice problems and occupations vary depending on the study populations, on the methods used in the studies and on how voice disorders are defined.

In Finland, data for several studies on occupation and voice disorders has been collected with similar questionnaires, mainly following the guidelines of the Tuohilampi Questionnaire, which is a pool of questions for epidemiological studies that was developed for the Finnish Institute of Occupational Health. One part of our questionnaire is about the prevalence of vocal symptoms. The symptoms enquired have been *The voice get strained or tires*, *The voice gets low or hoarse*, *Throat clearing or coughing while talking*, *Voice breaks while talking*, *A sensation of tension or lump in throat* and *Difficulty in being heard*. The participants have been asked to report symptoms occurring *during the past year* except for in two studies on voice problems in teachers were the time prevalence was two years. The frequency alternatives for the occurrence of the symptoms have been daily, weekly, seldom, or never. Questions concerning working environment, such as exposure to noise, questions about room acoustics and air quality and posture while talking have also been included.

The results show that the occupational groups with most voice problems (two or more symptoms occurring weekly or more often) are day care center teachers (34 %), soccer coaches (28%) and priests (27%). The results also reveal that the prevalence of two or more frequently occurring symptoms has increased from 2 to 17% in nurses and from 5 to 20 % in teachers.

In the study on day care center teachers by Sala et al. (2001) all participants underwent a laryngeal examination. The results revealed that those who reported two or more frequently occurring vocal symptoms often had an organic voice disorder. A questionnaire concerning vocal symptoms could be used as a simple screening method by occupational health care or other health care units in order to identify persons at risk for voice disorders for a closer medical examination and possible voice care.

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Stress is a risk factor for voice disorders - Why and for whom?

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The stress response is vital and essential for wellbeing. However, a rapid shut-down is essential for rest and recovery. In summary the short term acute stress leads to increased secretion of stress hormones, reduced pain sensitivity, increased blood coagulation, enhanced immune functions, reduced metabolic activity, and increased cognitive functions. During chronic stress the stress response becomes dysregulated. This happens when the stress response is too frequent, fails to shut down, the response system is oversensitive or fail to activate due to exhaustion The dysregulation of the HPA-axis leads to chronically elevated cortisol levels or attenuated cortisol levels. In contrast to acute stress, chronic stress is associated with increased pain sensitivity, elevated blood pressure, metabolic disturbance, impaired immune function and impaired memory function. Both acute and chronic stress might have consequences for voice production. Different results regarding the association between stress and voice symptoms are discussed. Evidence for stress as a risk factor for vocal symptoms is presented, and some of the factors influencing differences between individuals are discussed.

On teachers' dysphonic voice and the impact of noise and voice quality on children's performance

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The spoken word is the major means of communication in the classroom. The teaching profession is aknowledged as an occupation with high vocal demands and a heavy voice load. The classroom is a shared work-environment for teachers and children. Back-ground noice and adverse room acoustics have been shown to affect both teacher's voice and listerners' memory. The child's perception of the speaker's voice-quality and the possible consequences for comprehension and learning has however, been scaresly researched. The presentation will cover reports from a larger, ongoing project about the impact of teachers' voices on children's performance on language comprehension tests and cognition and also of the children's attitudes towards normophonic and dysphonic voices.

Voice ergonomics and children – future occupational voice users

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Voice Parameters and Acoustics in Schools

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In the UK the guidance document BB93 *Acoustic Design of Schools: performance standards* (2015) provides design guidance for school construction and refurbishment.

Traditionally, school acoustic design in the UK has been concerned with the needs of the listener, rather than the voice ergonomics of the speaker.

There are indications that teaching may carry a significant risk of developing voice problems and the size of the teaching population means that such problems have the potential to affect large numbers of individuals.

This presentation will detail research that has been born out of a practical need for further information and guidance for those concerned with acoustic design in schools in relation to considering the voice health of teachers.

In an effort to better understand the influence of classroom acoustic design on teachers' speech LSBU has undertaken measurements of teachers' voices in different classroom types.

An Ambulatory Phonation Monitor (KayPENTAX APM 3200) has been used to measure voice parameters (including the average speech sound level, fundamental frequency and phonation time) directly from the skin vibrations in the neck, thus eliminating the effects of other noise sources in the environment.

As well as the voice levels of teachers' general noise levels in the classrooms during lessons were also measured to determine the occupied noise levels during teaching.

The classrooms involved were acoustically benchmarked separately to enable to relationships between the voice data and acoustic parameters, such as unoccupied ambient noise levels and reverberation times, to be investigated.

This presentation will summarize the methodology of the field measurements, and discuss some of the findings.

Further details available in the paper:

Durup, N., Shield, B., Dance, S., Sullivan, R. and Gomez-Agustina, L., 2015. How Classroom Acoustics Affect the Vocal Load of Teachers. Energy Procedia, 78, pp.3084-3089. Available at: www.sciencedirect.com/science/article/pii/S1876610215024935

Acoustic design of school buildings for good listening and speaking conditions.

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The acoustic design of new schools and the refurbishment of existing schools provide a number of challenges which will be discussed in this presentation.

In the UK new schools have to comply with mandatory requirements for acoustics. These historically have been focused on providing good listening conditions for children rather than considering the voice ergonomics of teachers.

Due to population increases, particularly in urban areas, there is now great pressure for additional school capacity in many areas of the UK. This typically means that new schools are constructed in high noise areas which present make it difficult to achieve good acoustic conditions whilst needing to balance other considerations such as cost and sustainability.

The process of acoustic design from initial feasibility studies and design development through to the final testing before the school opens will be discussed and the impact on listening and speaking conditions.

The main acoustic considerations will be explained in this presentation including environmental noise intrusion, internally generated noise from school activities and ventilation equipment, reverberation times and speech intelligibility as well as classroom layouts and sizes.

The presenter has worked as an Acoustic Consultant in the UK for 9 years and has been involved in the acoustic design of a range of new construction schools and school refurbishments and will discuss the practical considerations in achieving good listening and speaking conditions.

Further details on the current guidance for the acoustic design of schools in England, Building Bulletin 93: 2015, can be found at:
www.gov.uk/government/publications/bb93-acoustic-design-of-schools-performance-standards

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Examples of acoustic treatments in school classrooms

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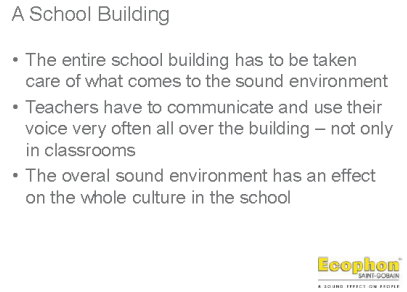

Discussions - What we can do in practice?

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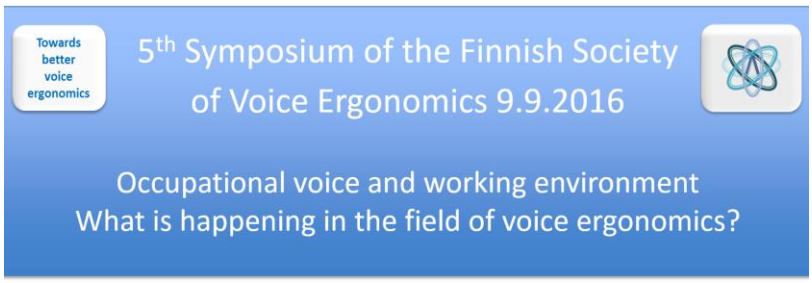

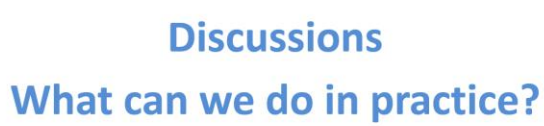

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